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14. ABSTRACT

There were two primary objectives of this Research Initiative: (1) to purchase and install an oxygen resistant Zn effusion cell to assist with challenges due to oxidation of source cells, and (2) to complete the installation process and facilitization of an existing ozone generation system for our MBE growth chamber. Under the project, both objectives were met. A research scientist in the group, Dr. Huiyong Liu, was trained in the operation of the ozone source, and the MBE system is now ready for ozone growth experiments to determine the effectiveness of the oxide

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## Report Title

Final Report

## ABSTRACT

There were two primary objectives of this Research Initiative: (1) to purchase and install an oxygen resistant Zn effusion cell to assist with challenges due to oxidation of source cells, and (2) to complete the installation process and facilitization of an existing ozone generation system for our MBE growth chamber. Under the project, both objectives were met. A research scientist in the group, Dr. Huiyong Liu, was trained in the operation of the ozone source, and the MBE system is now ready for ozone growth experiments to determine the effectiveness of the oxide resistant Zn cell and the impact of ozone based oxide semiconductor growth in comparison to the typical oxygen plasma based epitaxy.

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# Enter List of papers submitted or published that acknowledge ARO support from the start of the project to the date of this printing. List the papers, including journal references, in the following categories:

### (a) Papers published in peer-reviewed journals (N/A for none)

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**TOTAL:**

**Number of Papers published in non peer-reviewed journals:**

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### (c) Presentations

**Number of Presentations:** 0.00

## Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Received Paper

**TOTAL:**

**Number of Non Peer-Reviewed Conference Proceeding publications (other than abstracts):**

## Peer-Reviewed Conference Proceeding publications (other than abstracts):

Received Paper

**TOTAL:**

**Number of Peer-Reviewed Conference Proceeding publications (other than abstracts):**

## (d) Manuscripts

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**Number of Manuscripts:**

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Received Paper

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## Graduate Students

| NAME | PERCENT_SUPPORTED |
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**FTE Equivalent:**
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## Names of Post Doctorates

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| NAME | PERCENT_SUPPORTED |
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**FTE Equivalent:**
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The number of undergraduates funded by this agreement who graduated during this period: ...... 0.00

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Number of graduating undergraduates who achieved a 3.5 GPA to 4.0 (4.0 max scale):...... 0.00

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The number of undergraduates funded by your agreement who graduated during this period and intend to work for the Department of Defense ...... 0.00

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## Names of Personnel receiving masters degrees

NAME

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## Names of personnel receiving PHDs

NAME

**Total Number:**

## Names of other research staff

| NAME | PERCENT_SUPPORTED |
| --- | --- |

**FTE Equivalent:**
**Total Number:**

## Sub Contractors (DD882)

## Inventions (DD882)

## Scientific Progress

## Technology Transfer

**Period Covered By Report**: 09/01/2012 to 08/31/2013

**Proposal Title**: "Research Initiative (RI) Proposal to Enhance Oxide MBE Growth through Facilitization of an Ozone Source and Oxygen Resistant Zn Effusion Cell"

**Contract Number**: W911NF1210429

**Author:** Prof. Winston V. Schoenfeld (PI)

**Performing Organization**: University of Central Florida
12201 Research Parkway, Suite 501
Orlando, FL 32826-3246

**Key Words**: Oxides, Oxide semiconductors, ZnO, MgZnO

## Abstract

There were two primary objectives of this Research Initiative: (1) to purchase and install an oxygen resistant Zn effusion cell to assist with challenges due to oxidation of source cells, and (2) to complete the installation process and facilitization of an existing ozone generation system for our MBE growth chamber. Under the project, both objectives were met. A research scientist in the group, Dr. Huiyong Liu, was trained in the operation of the ozone source, and the MBE system is now ready for ozone growth experiments to determine the effectiveness of the oxide resistant Zn cell and the impact of ozone based oxide semiconductor growth in comparison to the typical oxygen plasma based epitaxy.

## Technical Report

There were two primary objectives of the project: (1) to purchase and install an oxygen resistant Zn effusion cell to assist with challenges due to oxidation of source cells, and (2) to complete the installation process and facilitization of an existing ozone generation system for our MBE growth chamber.

Both objectives were met under the project. First the oxygen resistant Zn effusion cell was purchased from SVT Associates (SVTA) in Eden Prairie, MN and was installed in the growth chamber as a Zn source for growth. Figure 1 provides an image of the source shown installed to the growth chamber.

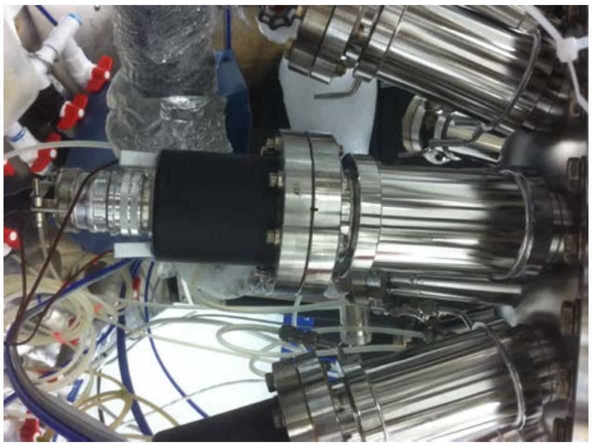

**Figure 1. Photograph of the installed oxygen resistant Zn source on the MBE growth system.**

We were also successful in completing the installation of the ozone generation system on the MBE. Initial work focused on locating the ozone system adjacent to the MBE system in a suitable position, as shown in Figure 2.


**Figure 2. Photograph of the ozone system, positioned adjacent to the MBE system.**

We discovered the need for installation of additional power outlets due to safety requirements about extension cords in the lab. This was carried out by university facilities, as required, and the proper power was put in place for the system to meet fire and safety codes. We then arranged a visit by Ralf Hartmann from SVTA to come and verify that the system was operational. We were successful in generating ozone with the system as it is designed, but did not send this into the growth chamber due to the need to obtain a larger diameter stainless line from the ozone system to the injector on the MBE system. The current line was ¼" diameter, and it was recommended that we increase to a ½" diameter line to reduce pre-reaction of generated ozone as it is delivered to the MBE injector. Following the recommendation, we drew up a diagram for a ½" diameter stainless line with the proper fittings and also decided to incorporate an ozone optical monitoring system into the source line to the injector, and procured the line.

Figure 3 shows an image of the source line we installed that connects the generator to the injector on the MBE system. The inset highlights the inline ozone optical monitoring system that is capable of qualitatively monitoring the level of ozone being delivered to the MBE injector. This is a very valuable metrology tool given that it can assist in ensuring we utilize similar ozone delivery conditions during growth, much like a flux monitor ensures that source flux is equivalent to prior levels.

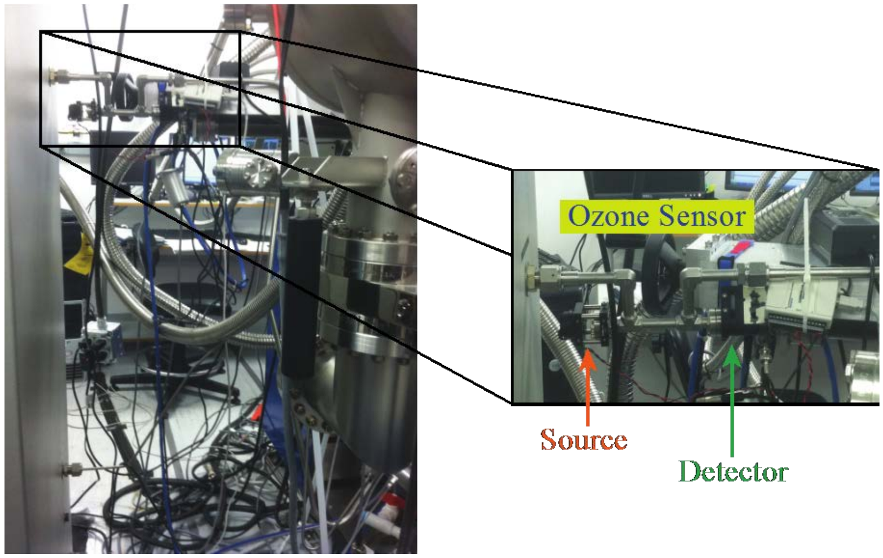


**Figure 3. Photograph of the source line from the ozone system to the MBE system. Also shown is the inline ozone monitoring system that was installed to help monitor ozone delivery during operation.**

Through the funded project, we have successfully prepared our MBE system for longer growth cycles due to the oxygen resistant Zn cell and are also positioned to carry out studies of oxide MBE growth using the ozone source. To our knowledge, we are the only group in U.S. with an ozone system and are positioned to advance our national understanding of the value of ozone growth of ZnO and related compounds in comparison to the traditional oxygen plasma growth that many use. We consider the project successful and that it met its goals (two primary objectives), enhancing the capability of our MBE growth and making us more capable of supporting the needs and interest of the U.S. Army.